Abstract for a presentation to be given by Henry Wilhelm at the Photographic Materials Group session on Thursday, May 31, 2018 at the 46th Annual Conference of the American Institute for Conservation of Historic and Artistic Works (AIC) in Houston, Texas – May 29 to June 2, 2018

Comparison of LED, L-37 Filtered Xenon Arc, and Glass-Filtered Cool White Fluorescent Illumination in the Light Fading and Light-Induced Staining of Color Photographs

Henry Wilhelm (Wilhelm Imaging Research, Inc., Grinnell, Iowa, USA)
and Richard Adams (Ryerson University, Toronto, Ontario, Canada)

During the past several years, there has been a large-scale shift from UV-filtered tungsten halogen illumination to high Color Rendering Index (CRI) LED illumination in museums, galleries, archives, and libraries, along with widespread adoption of generally lower CRI lamps in public buildings, commercial establishments, and homes. The majority of light stability information on the indoor fading and staining of analog and digitally-printed color photographs published in the past 30 years has been based on accelerated tests conducted with glass-filtered and UV-filtered Cool White fluorescent illumination. At the present time, for a number of important reasons, Wilhelm Imaging Research, HP, Epson, and Kodak Alaris, among others, continue to conduct accelerated light fading tests using this illumination source.

However, "ISO International Standard 18937:2014, Imaging materials – Photographic reflection prints – Methods for measuring indoor light stability," specifies L-37 filtered xenon arc illumination for "simulated display in indoor indirect daylight through window glass." JEITA Standard CP3901A also specifies L-37 filtered xenon arc illumination. Work is currently in progress on "ISO 18937-4, Imaging materials – Photographic reflection prints – Methods for measuring indoor light stability – Part 4: LED Illumination." Working together with Shigeo Suga of Suga Test Instruments of Tokyo, Japan, Henry Wilhelm is serving as Co-Project Leader in the development of this new ISO standard. Wilhelm Imaging Research, Inc. has designed and constructed new temperature and humidity-controlled accelerated light stability test equipment for LED lamps.

This paper will present comparative fading and staining data for a representative group of color photographic print materials, including silver-halide color (chromogenic) prints made with Kodak Alaris Endura Premier Professional Paper and Fujicolor Crystal Archive PDN Professional Paper (also to be discussed is the newly-developed "Improved Light-Stability" Fujicolor Crystal Archive Professional Paper that was publicly announced at the IS&T Digital Printing Technologies Conference in Denver, Colorado on November 8, 2017, and will be commercially introduced in September 2018 at the Photokina trade show in Cologne, Germany); Epson UltraChrome HDR pigment inkjet prints; Epson EcoTank (Epson 664 dye inks) dye inkjet prints; ChromaLuxe dye-sublimation photographs printed on an intermediate transfer paper with Epson UltraChrome DS (dye sublimation) inks and then thermally transferred under high heat at 190–205°C (375–400°F) and pressure (60–80 PSI) for 2–4 minutes onto a rigid, specially coated ChromaLuxe aluminum support; and ChromaLuxe dye-sublimation photographs printed in the same manner with Sawgrass 8-color Sublijet HD Pro Photo XF dye-sublimation inks.

The prints have been subjected to accelerated tests using high-intensity 25 klux LED illumination from SORAA Vivid PAR 38 violet (purple) pump emitter LED lamps with a CRI of 95 and CCT of 3000K (1000 lumen output, 60°FL, 18.5-watt SORAA SP38-18-60D-930-03) with glass-filtered, UV-filtered, and non-filtered (bare-bulb) exposure conditions. For comparison purposes, prints have been exposed to illumination from single-phosphor OSRAM Sylvania High Output (HO) 4200K Cool White (JIS F-6) fluorescent lamps (made in Canada) with glass-filtered, UV-filtered, and non-filtered bare-bulb exposure conditions. In addition, in ongoing tests, prints have been exposed to xenon arc illumination (equipped with water-cooled Hoya L-37 glass filters and dual IR filters) in a Suga SX75F temperature- and humidity-controlled xenon arc test unit equipped with dual refrigerated chamber air and water-jacketed xenon lamp cooling systems that simulate indoor indirect daylight through window glass, both with and without a UV filter. Illumination levels, sample surface temperature, test chamber temperature, and relative humidity conditions have been maintained as close as possible to the same aim-points. Identical methods of test target measurement and analysis for reporting fading and staining data are employed.

Tungsten-halogen and L-37 filtered xenon illumination, however, present a number of difficult technical issues in terms of maintaining uniform sample surface temperatures, moisture levels, uniform illumination levels, and mitigating other factors that can result in poor inter-laboratory agreement between different testing organizations, and this will be discussed in the presentation. The spectral power distributions in the UV, Visible, and IR regions for all of the illumination sources will be given, including the spectral properties of LED lamps based on blue pump emitters and LED lamps based on violet (purple) pump emitters.

Related topics that will briefly be discussed include: Lux (a measure of light intensity as perceived by the human eye – and its generally not straightforward relationship to rates of fading and light-induced staining), Color Rendering Index (CIE CRI), IES TM-30-15, Television Lighting Consistency Index (TLCI), Color Quality Scale (CQS), and Correlated Color Temperature (CCT) for LED lamps will be described. Potential differences between blue pump emitter LED illumination and violet (purple) pump emitter LED illumination in terms of their potential impacts on the fading rates of color photographs – and, likely, paintings, watercolors, other works of art, fabrics, books, and historically important paper documents – will also be discussed.

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